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A SIMPLE METHOD FOR MODELING THE EFFECTS OF INTER-PLANE SEPTAL SHIELDS IN PET CAMERAS*. **W.W. Moses, S.E. Derenzo, R.H. Huesman, and T.F. Budinger, Life Science Division, Lawrence Berkeley National Laboratory, Berkeley, CA.**

In recent years there has been a trend in PET camera design to remove inter-plane septa and/or alter geometry (increasing axial extent or reducing detector diameter) to increase sensitivity. However, this greatly increases the acceptance of background from random coincidences and scatter. In fact, simultaneously removing all inter-plane septa and increasing the solid angle coverage can significantly degrade the camera performance due to the greatly increased random coincidence contribution caused by activity outside the field of view. While a detailed Monte Carlo simulation is the preferred method for evaluating different camera geometries, we present general conclusions based on a simple analytic method to rapidly evaluate different geometries.

We have quantified the Noise Equivalent Count (NEC) performance of PET cameras as a function of the number of septa. We confirm that while the peak NEC rate is only weakly affected by the number of septa, the activity at which the peak occurs and the sensitivity are strongly affected by the number of septa. The data suggest that a good tradeoff between sensitivity and background is obtained with septa spaced wider apart (2–3 cm) than currently popular. We also find that a large number of septa are needed to effectively shield activity from outside of the field of view; ~15 tungsten septa (1 mm thick) are necessary to increase the maximum activity by a factor of 2.

The method used is a multi-plane extension of an analytic model [1]. The detector is divided axially into 1 mm thick rings, each denoted by an index *i*. The source is also divided axially and given index *k*. The acceptance for singles is given by $A_{ik} = \Omega_{ik} P_{ik}$, where Ω_{ik} is the solid angle subtended by detector plane *i* around source point *k* and P_{ik} is the probability for the 511 keV photon to penetrate the shielding material and be detected. From the acceptance factor we calculate $\text{True} \quad \rho \sum_k \sum_i A_{ik} A_{i_{opp} k}$, where ρ is the activity density, as well as $\text{Scatter} \quad \rho \sum_k \sum_i \sum_j A_{ik} A_{jk}$, $\text{Singles}_i \quad \rho \sum_k A_{ik}$, and $\text{Randoms} \quad \sum_i \sum_j \text{Singles}_i \; \text{Singles}_j$. These rates are modified to reflect detector dead time and coincidence processor rate limitations, and the proportionality factors determined either from first principles (as in [1]) or by comparing to published data. If the source is constrained to lie on the central axis of the camera, the solid angle factor Ω_{ik} is easily computed analytically. An entire NEC versus activity density curve for a camera with many septa is calculated in a few seconds on a desktop computer, and agrees with published data to within 10%.

[1] S.E. Derenzo, J. Nucl. Med. 21, pp. 971–977, 1980.

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